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COGNITIVE PROCESSING OF BLISS-LIKE

SYMBOLS BY NORMAL POPULATIONS:

A REPORT ON FOUR STUDIES

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ABSTRACT

Four studies were conducted to investigate the cognitive processing of Bliss-like symbols by normal populations. The first two studies, designed to obtain ratings on the dimension of Representativeness, the degree to which a symbol represented the concept paired with it, resulted in ratings for 303 symbols. Comparison with other dimensions such as concreteness and imagery, revealed low positive correlations. The third study, an incidental learning task, sought to find intrinsic characteristics of symbols which enhance their learning. Correlations calculated between the mean recall of items across subjects and the values for representativeness and concreteness were significant at the .001 and .01 levels of confidence respectively. Descriptive Analysis suggested S's tended to retain the nominal response pairs with the symbol versus the "class" of item generally reported with learning of graphic representations. The fourth study, a paired-associate experimental design manipulated symbol-word variables directly. Results supported findings in the previous three studies and indicated that an interaction between representativeness of symbol and concreteness of its concept has an effect on learning.

INTRODUCTION

In the book, Semantography-Blissymbolics (1965) C. K. Bliss proposed an international symbol language. In 1971, the Symbol Communication Program at the Ontario Crippled Children's Centre, discovered the symbols in the book, "Signs and Symbols Around the World" by Helfman (1967). The Blissymbols were first introduced to severely physically handicapped cerebral palsied children with normal intelligence. From these early beginnings, clinical application has been extended to a variety of handicapped populations (physically handicapped, mentally retarded, multiple handicapped, deaf, aphasics, autistic, blind and language delayed [Bulletin, 1977]), in over three thousand centres throughout North America and Europe (Archer, 1977). Research with the symbols has not kept pace with the clinical applications and has, for the most part, consisted of clinical studies (Kiernan, 1977; Harris-Vanderheiden, et.al. 1975; Ross, 1979; Song, 1979; Galloway, 1978). Clinical studies are difficult to interpret without normative data, consequently the present study was designed to obtain information on the "cognitive processing" of Bliss-like symbols by normal populations. This information might allow for a more qualitative and quantitative assessment of the results obtained with the handicapped.

The term "Bliss-like" symbols is used to describe the representations employed in the four studies. Since their first introduction, Blissymbols have been constantly modified by both C. K. Bliss and the Bliss Communication Institute (BCI) to meet the ever changing needs of the clinicians and populations employing them. The configurations adopted in the present studies were obtained from both sources. The passage of time between studies gives rise to the probability that one or both of

of the sources' criteria may be violated. Therefore the term "Bliss-like" was used to avoid the problem of occasionally not being able to adhere to these criteria. The task was to investigate the processing of graphic non-verbal representations of concepts by a normal adult population. The use of the two sources, Semantography and BCI, allowed for a more general interpretation of the data. The symbols, initially drawn to conform to Semantography criteria and rated as to their degree of representativeness (Studies 1 and 2), were later reconstructed to conform to contemporary standards of the BCI (Hehner, 1980) with the restriction that the BCI and Semantography representations of any one symbol did not differ significantly in their configurations.

The purpose of the four studies was to develop an instrument, similar to the concreteness values of words developed by Paivio, Yuille, and Madigan (1968). This could later be manipulated in an effort to investigate the cognitive processing of symbols. The symbol attribute of "representativeness" (R), defined as the degree to which a Bliss-like symbol represents the concept paired with it, was selected as the agent to be developed. The design used by Paivio et al. (1968) was modified to accomodate the symbol-word pairings.

STUDY #1

Three hundred and three nouns were randomly selected from the Paivio et al. (1968) list and matched with a symbol, from Semantography (1965), which represented the same concept. These symbol-word pairs were randomly arranged, 36 to a page; the 8 1/2 page booklet was also arranged in a random page sequence with the exception of the 1/2 page, which always came at the end of the protocol. The subjects, 20 male and

20 female undergraduate students, not familiar with Blissymbols and from the Health Sciences Faculties, were individually tested in a quiet setting. They were given written and verbal instructions, demonstration items, and asked to respond to all the test items without looking back. Eighteen pairs of words, depicted by the same symbol, were included as a test of intra-subject reliability. Subjects rated the items for the degree of representativeness on a seven point equal-appearing interval scale (Paivio, 1968). Low representativeness was indicated by low numbers and high degree of representativeness was indicated by high numbers.

The resultant ratings ranged from 1.18 to 6.98, suggesting that subjects utilized the full extent of the scale in their ratings (overall mean = 3.40). However the results were slightly skewed to the low end of the scale (47.5% of the symbols were rated as less than 3.0 and 12.3% were rated as 5.0 or above). These results were obtained in spite of the fact that the 303 nouns selected tended to be high in concreteness and imagery value (overall means: concreteness = 5.19, imagery = 5.32).

The intra-subject reliability based on 18 repeated items revealed a high positive correlation ($r = .893$), suggesting that the reliability of the ratings is satisfactory. Correlations were also computed between symbol representativeness and the values established for concreteness, imagery, meaningfulness, printed familiarity and Thorndike-Lorge frequency of occurrence of the words. The results of the analyses are presented in Table 1. Low positive correlations were found between representativeness of the symbols and the other variables ($p = .001$ level for Imagery and meaningfulness; $p = .003$ level for concreteness

and $p = .004$ and $.04$ level for printed familiarity and Thorndike-Lorge frequency respectively). Dependent t-test analysis of the ratings between the male and female subjects, indicated that female S's rated the symbols significantly higher in the degree of representativeness than did the males ($t = 8.37$, $p = .001$, $df = 302$).

STUDY #2

The second study, a replication of the first, was carried out with individuals who had taken at least one course in the use of the symbols with the handicapped, from the BCI. Though the stimulus symbols conformed to the original configurations of C.K. Bliss (1965), it was predicted that knowledge of the BCI system would enhance the ratings. The prediction was supported as the "experts" rated the symbols significantly higher on the attribute of representativeness (mean = 4.23, $t = 14.0$, $p = .001$) than the naive subjects. The "experts" ratings of representativeness correlated .338 with imagery and .243 with concreteness. These values are somewhat higher than those shown in Table 1 for the naive subjects.

STUDY #3

The third study, an experimental test of incidental learning, consisted of two conditions: short term memory (STM, $N = 28$) and long term memory (LTM, $N = 14$). The undergraduate students serving as subjects were selected in the traditional manner to insure randomness of selection and lack of familiarity with the symbols and experiment. Both groups were required to carry out the distraction portion of incidental learning experiments, in this case the rating task of Study #1. Immediately upon completion of the rating task, the participants in the STM condition were

handed a new sheet where the 303 symbols were in different order and not accompanied by the written words. They were asked to write the words that had been previously paired with each symbol. The members of the LTM group returned within a three week period at which time they were asked to recall the nouns that had been paired with the symbol cues. Subjects in the STM task correctly recalled 28% of the word responses to the symbol stimuli. An additional 7.2% of their responses were synonyms of the words originally paired with the symbols. If one views the synonym response as correct, this increases the correct response percentage to 33%. In contrast, subjects in the LTM group were only able to recall 4.4% of the words and an additional 2.3% of their responses were synonyms of the correct word, for an overall correct recall percentage of 6.6%. It can be seen in Table II that correlations, calculated between the mean recall of items across subjects and the values for representativeness, were significant at the .001 level of confidence ($df = 301$). Similar calculations (Table II) show a lower, but still significant correlation, ($p = .01$, $df = 301$), between mean recall of items across subjects and the values for concreteness of the word concepts.

STUDY #4

The fourth study was a paired-associates recall experiment. Twenty-four subjects, 12 male and 12 female university students (age range 18 to 24 years, mean = 19.8 and median = 19.5 years), with no prior knowledge of Bliss-like symbols, were presented four 16 item lists of symbol-word pairs in random order. The factors of representativeness of symbol and concreteness of word were orthogonally varied on two levels, high(H) and low(L), corresponding to a two factor randomized block design (Kirk, 1968).

Table IV shows the construction and examples of the four lists. Subjects were tested individually in both STM and LTM conditions with all stimulus materials presented in the form of slides projected on a screen at 5 second intervals. During the STM condition, the presentation of the list to be learned, was followed by a 10-15 second interval after which the symbols, reordered from the learning sequence, were presented for 8 seconds during which time the subject was required to give a verbal response. The second dependent variable, long term memory (LTM) was tested within eight days of the learning trial using the same subjects and following the same testing procedures as in the STM condition. The 64 stimulus symbols were presented in a new random order at eight second intervals.

The results were analyzed descriptively and statistically using BALANOVA, a Two Factor Analysis of Variance, separately for STM and LTM conditions. The analysis of results yielded significant main effects for both representativeness of the stimulus symbol, $F(84.288)$, $df = 23$, $p < .001$, and concreteness of the response word, $F(26.614)$, $df = 23$, $p < .001$. The interaction was not significant. In contrast the LTM condition revealed significant F's for both main effects and the interaction. Comparisons using Dunn's t-test revealed significant differences between all conditions except between High representative-Low concrete pairs and Low representative-High concrete pairs (Figure 1).

A t-test analysis was also conducted to determine whether the responses of males and females were different for STM and LTM. Results indicated no significant differences between the two groups. Mean recall for all subjects between the STM and LTM conditions were significantly

different. Analysis of results indicated significant differences in mean recall for all S's between the STM and LTM conditions ($t = 17.5$, $p = .001$, $df = 95$, $r = .820$).

Discussion and Conclusions

Studies 1 and 2 yielded data on the degree to which Bliss-like symbols were representative of the words paired with them. The words, although slightly skewed towards the concrete end, were representative of the full range of the abstract-concrete continuum. The dimension of representativeness was found to have a low positive correlation with imagery, concreteness, and meaningfulness (Table 1). This suggests that representativeness is sufficiently independent of the other dimensions that it can be interpreted and manipulated separately. The experts' ratings of representativeness correlated highly ($r = .772$) with concreteness value of the matched word. In addition their mean values for representativeness was significantly different from the representative ratings of naive subjects ($t = 14.0$, $p = .001$, $df = 304$). These findings support the contention that knowledge of the language members of Bliss symbols is important to the acceptance of the meanings of the configurations.

The Incidental Learning task of Study 3 was designed to reveal intrinsic characteristics of the symbols that enhance their learnability: The results suggest that the most effective characteristic for both STM and LTM is the degree to which a symbol is perceived as being highly representative of the concept (Table 2). Examination of the items recalled in both STM and LTM conditions revealed that 27.7% of the items in the STM condition and 63% in the LTM condition were rated high on both dimensions of representativeness of symbol and word concreteness.

This implies that a symbol is learned easily when it is an iconic representation of a concrete concept.

The paired-associates study manipulated stimulus characteristics directly to study their effects on learning. The dimensions of representativeness of the symbols and concreteness of the words were varied as were the abstractness-concreteness of words (Yuille, 1967). Generally, representativeness of symbol and the concreteness value of verbal label had an interactive effect on learning. Examination of pairs which did not elicit a response from 25% or more of the subjects in both STM and LTM paired associate conditions came from all but the list made up of symbol-word pairs which were high representative symbols matched with high concrete verbal labels (Table 3). This finding further supports the conclusion of the incidental learning task; that iconic symbols matched with their concrete verbal representation are more easily learned.

The results of the four studies should be interpreted with caution for several reasons. First they were conducted on adults who had some University education. Second it is impossible to assess the degree to which interference, of established representations for the concepts, affected results. For example, subjects may have a representation of "FREEDOM" that is not consistent with the Bliss-like representation for this concept (Table 4). During the paired-associates task it could be expected that the subjects' experienced interference with symbols (like Freedom) which were less representative of verbal labels rated as concrete. Third, items used in the paired associates experiment were dependent upon the representativeness ratings in Study #1. Symbol-word pairs matched for low representativeness of symbol and high concreteness

of word or low representativeness of symbol and low concrete value of word were difficult to construct. Therefore of the 16 symbol-word pairs in the low representativeness-low concreteness list, half of the compound symbol configurations had the "heart" as one of its components. This fact must certainly have been a confounding variable contributing to the results seen in Figure 1 (LRLC lowest mean recall scores).

One of the primary goals in the investigation of cognitive processing of symbols is to address the issue of how they are stored. Paivio's (1971) Dual Coding Hypothesis, which deals with the nature of verbal and nonverbal representations and their interpretations, might be a useful approach in studying the processing of graphic non-speech communication systems. The studies conducted for the present investigation are considered ground work necessary to address the more theoretical issue of cognitive processing of such systems.

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TABLE 2. Correlations of Representativeness and Concreteness with mean recall of the 303 items across subjects on the incidental learning task.

	Representativeness	Significance Level	Concreteness	Significance Level
STM n = 28 Nominal recall	0.689	.001	0.301	.01
Synonym recall	0.729	.001	0.329	.01
LTM n = 14 Nominal recall	0.575	.001	0.204	.01
Synonym recall	0.622		0.209	.01

Concept	# of S's of n=24 who missed the item	Percent S's who missed item	List concept occurred in			
			HRHC	HRLC	LRHC	LRLC
ABILITY	15	63%				x
AFFECTION	7	29%		x		
BELIEF	6	25%				x
CREATURE	10	42%			x	
GRAVITY	6	25%		x		
HUMOUR	10	42%				x
INTELLECT	11	46%				x
INTEREST	8	33%				x
MEAT	8	33%			x	
METAL	8	33%			x	
METHOD	13	54%				x
NECESSITY	7	29%				x
SENSATION	6	25%		x		
SHAME	14	58%				x
THOUGHT	7	29%				x
TRUTH	15	63%				x
TOTAL			0	3	3	10
Percent			0	18.75	18.75	62.5

Table 3. Experiment #4 Examples of concepts which did not elicit a response from 25% or more of the S's in both STM and LTM conditions.

TABLE 4. Examples of paired associates constructed using bipolar analysis of: Representativeness (R) ratings from study #1 and Concreteness values of nouns (Paivio, 1968).

HRHC (R= > 5.5 ; C= > 6.45)		HRLC (R= > 4.58 ; C= < 3.57)	
			
HOUSE	(TALO)	TIME	(AIKA)
			
FLAG	(LIPPU)	SADNESS	(SURU)
			
STAR	(TÄHTI)	HEARING	(KUULO)
LRHC (R= < 2.3 ; C= > 6.03)		LRLC (R= < 3.18 ; C= < 2.97)	
			
ROCK	(KIVI)	AFTERLIFE	(KUOLEMAN JÄLKEINEN ELÄMÄ)
			
BLOOD	(VERI)	FREEDOM	(VAPAUUS)
			
CABIN	(MAJA)	THOUGHT	(AJATUS)

* Symbols taken from "Blissymbols for Use",Hegner,B.,Ed.1980.

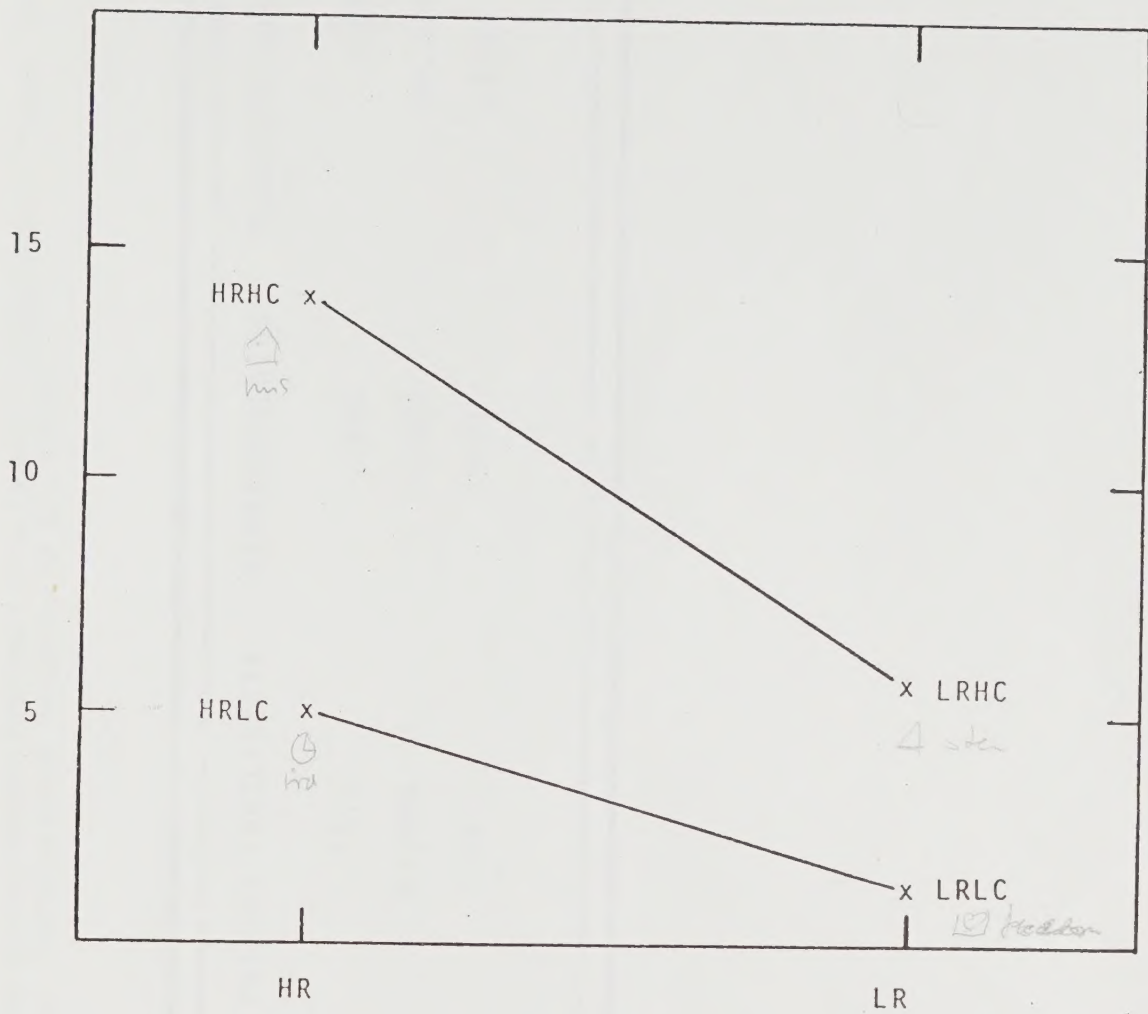


Figure 1. Mean recall scores for the different LTM conditions.
Significance was found between all but the HRHC-LRHC lists.

TABLE 1. Correlations of Representativeness (ratings) with Imagery, Concreteness, Printed Familiarity, Meaningfulness, and Thorndike-Lorge frequency of occurrence.

IMAGERY	CONCRETENESS	PRINTED FAMILIARITY	MEANINGFULNESS	THORNDIKE-LORGE FREQ.
.2669	.1590	.1510	.1850	.1030
S=.001	S=.003	S=.004	S=.001	S=.037
(303)	(303)	(303)	(303)	(303)

